ECE 470 POWER SYSTEMS I

Lab # 9 Symmetrical Components

In this lab, you will establish unbalanced phase voltages and determine the positive, negative and zero sequence components by calculation and measurement.

PRE-LAB

Perform the following calculations given that:

$$\begin{bmatrix} V_{an} \\ V_{bn} \\ V_{cn} \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} \begin{bmatrix} V_{a0} \\ V_{a1} \\ V_{a2} \end{bmatrix}$$

i) $V_{a0} = 50/\underline{-60}$ V, $V_{a1} = 120$ V, $V_{a2} = 0$ V
ii) $V_{a0} = 0$ V, $V_{a1} = 120$ V, $V_{a2} = 50$ V
iii) $V_{a0} = 50/\underline{-60}$ V, $V_{a1} = 120$ V, $V_{a2} = 50$ V

LAB PROCEDURE

The variable supply represents the negative sequence voltages and its output is fed through the three-phase transformer bank, with wye-connected primaries and isolated secondaries. This produces three individual phase voltages which can be connected independently.

Use the ohmmeter to check the continuity inside each transformer. **Be sure to use the fuses in the blue boxes to protect the transformers.** The three independent outputs are connected in series with the fixed three-phase supply, which represents the positive sequence voltages. The reversal of phase-sequence is achieved by connecting the C and B phases of different supplies in series. In order to generate zero sequence voltages, the variable single-phase supply is connected in the neutral of the three-phase supply; note that there is an inherent -60° phase-shift when you do this.

The transformers have to be used because the power supplies are wye- connected with the star point inside the bench. This prevents the two supplies from being connected directly in series.

The necessary circuit is shown on the next page. The thick lines represent connections that are hard-wired inside the bench, so you only have to wire the connections shown by the thin lines.

Arrange to view all three phase voltages (A', B' and C' to N') on the oscilloscope. **Be sure to turn both variable supplies down to zero before switching-on.**

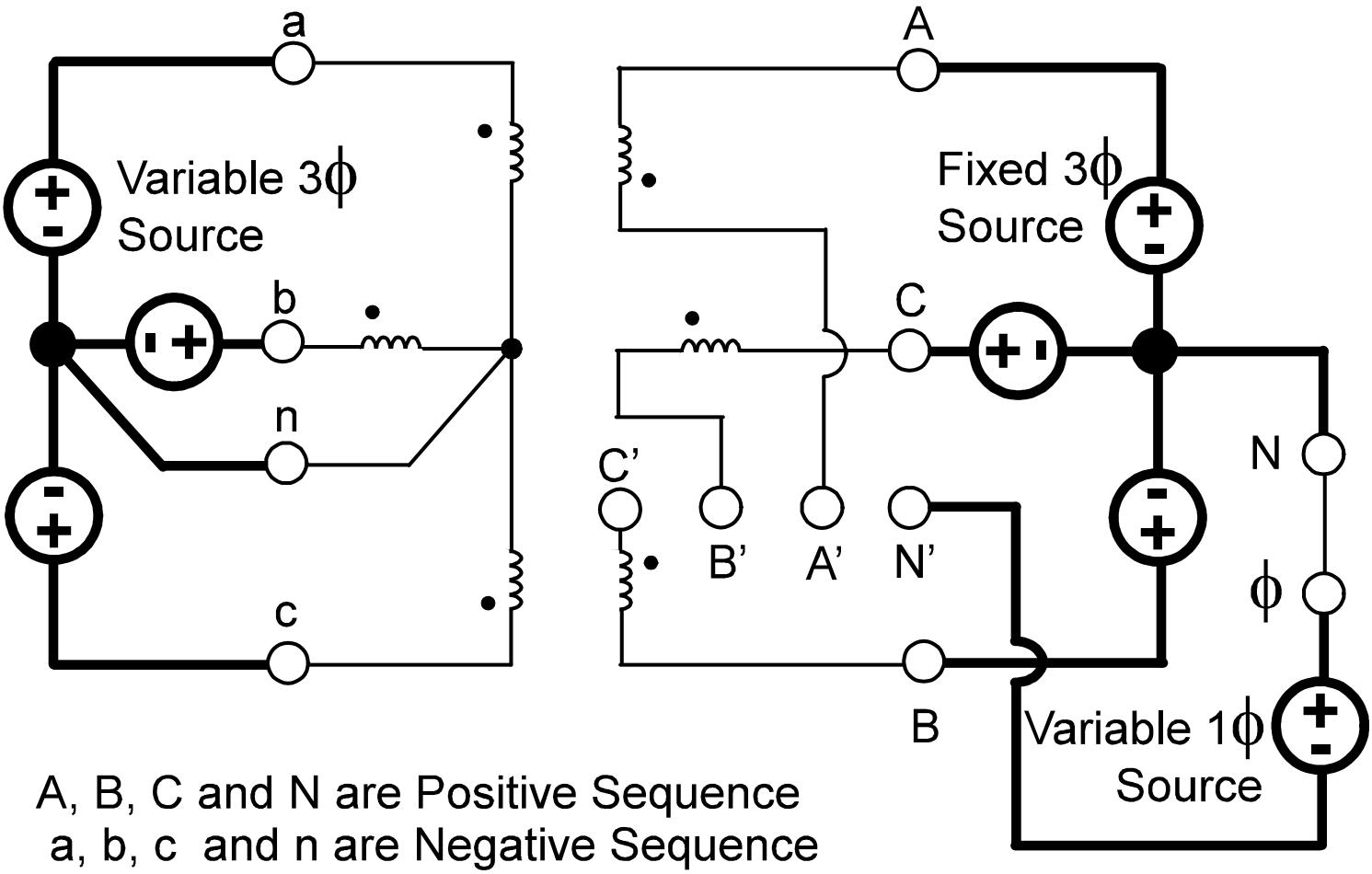
1. View the phase voltage waveforms and observe the effect of increasing the zero-sequence component. When this reaches about 50 V (phase) distortion is visible, measure the magnitudes and phase shifts from the oscilloscope and plot (or photograph) the waveshapes. Repeat this for the line voltages.

2. Measure the magnitudes of the positive and zero-sequence voltages; noting that the 1ϕ supply has a -60° phase-shift. Apply transformations and calculate the phase and line voltages which result (just like the pre-lab.) Compare this to the measurements of part 1.

3. Turn the zero-sequence supply down and repeat parts 1 & 2 with 50 V of negative-sequence component.

4. Now repeat parts 1 & 2 with all three sequence components.

5. Arrange your results in summary form and be ready to discuss them with the instructor.



A, B, C and N are Positive Sequence
a, b, c and n are Negative Sequence

A', B', C' and N' are the outputs